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# Spatial Distribution of Organic Matter Content in Plough Layer of Balikh Flood Plain Soils Northeastern of Syria

*Hussam H. M. Husein[1]*, Jaber Azawi[2], Mohammad Mousa[1]*

[1]General Commission for Scientific Agriculture Research, Damascus, Syria, hussam_syr1@yahoo.com
[2]Department of Soil and Land Reclamation, Faculty of Agriculture, Aleppo University

## Abstract

The study was carried out in Beer El_Hashem arable lands, during spring and summer 2012. The area located on the left bank of Euphrates river, 40 km northern west of Raqqa city center extend on 15 000 hectare, adjacent to Al-Balikh river and its tributaries on height about 290m (a. m. s. l). 30 up-soil samples were collected using free survey method in order to evaluation of agricultural and management practices for this continuously cropped land by mapping spatial distribution of organic matter in plough layer.

Result showed that soil dominated by alluvial soil originated from alluvial and proluvial Quaternary depositions, and soil organic matter content varies from poor to very poor. Thematic map and the main statistical moments, which are generally accepted as indicators of the central trend and of the data spread, were analyzed (mean, variance, coefficient of variation and extreme maximum and minimum values etc) were as following: mean 0, maximum1.92, mean 0.84, median0.9, RMS 0.96, variant 0.22, SD 0.47, range 1.9, mean difference 0.54.

*Keywords: Organic matter, spatial, Coefficient of variation, thematic map, Balikh river.*

## Introduction

Knowledge of spatial variability of soil organic matter content and relationships among soil properties is important for soil evaluation and agriculture practices. Spatial variability of soil properties is influenced by both intrinsic (soil formation factors) and extrinsic factors (e.g. soil management practices, fertilization and crop rotation). Some differences in parent materials, topography, climate and animal activities (including human being) result in variability of soils, even in a small scope (Jenny 1941). Understanding these patterns both gives us more information about what caused them and what processes they might affect. Moreover, the heterogeneity and variation of soil properties should be monitored and quantified for leading to more efficient farming practice and soil protection. Soil variability affects every one of our measurements and predictions.

### Scope and main objectives

The main objectives of this study were to:

Assess the spatial variability of soil organic matter content on intensively cropped Balikh plain.

Particular emphasis was paid on statistical and geostatistical analyses of spatial distribution of organic matter content and interaction between soil microrelief and soil organic matter content.

## Methodology

### The study area

The study has been carried out on Beer El_Hashem plain, which is located on the left bank of Euphrates river, 40 km northern west of Raqqa city centre, adjacent to Al-Balikh river and its tributaries on height about 290m (a. m. s. l).

### Soil sampling and chemical analysis

Spatial variability of soil properties were estimated on 15 000 hectare of Beer El_Hashem arable lands, being under long-term annual conventional tillage. 30 bulk soil samples were collected from plough layer using free survey method in order to evaluation of agricultural and management practices for this continuously cropped land by mapping spatial distribution of organic matter in plough layer, Figure 1. The sample locations were restricted using a GPS. The samples were air-dried and ground to pass through 2 mm sieve prior to analysis. The organic carbon content in fine earth was determined by dichromate oxidation **(**Nelson and Sommers 1982).

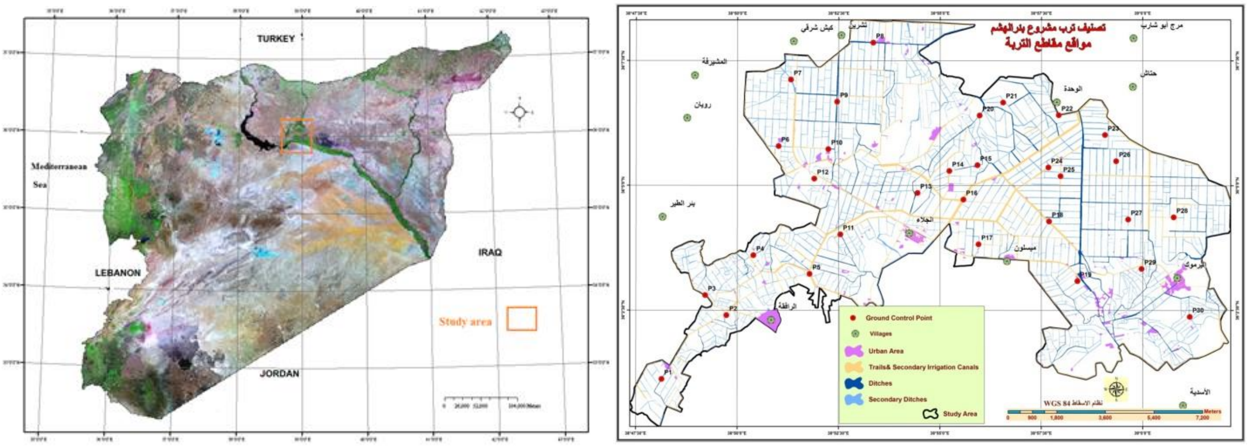

**Fig. 1: Fig. 1: Location of study area on general map of Syria and soil sample area.**

## Statistical and geostatistical analysis

The main statistical moments, which are generally accepted as indicators of the central trend and of the data spread, were analyzed. This includes examination of mean, variance, coefficient of variation and extreme maximum and minimum values.Spatial variability of organic matter contents was assesseyed through the analysis of semivariograms of the selected individual variables. Experimental semivariograms were obtained from the omnidirectional semivariances, $\gamma(h)$, as a set of spatial observations, $Z(x_i)$, which were calculated as:

$$\gamma(h) = \frac{1}{2N(h)} \sum_{i=1}^{N(h)} \left[z(x_i) - z(x_i + h)\right]^2 \qquad [1]$$

where: $z(x_i)$ and $z(x_i + h)$ are experimental measures of any two points separated by the vector $h$, and $N(h)$ is the number of experimental pairs separated by $h$.

In practice, a semivariogram simply enumerates the relationship between the degree of similarity between two measurements of some variable $Z(x_i)$ separated by distance h, which is termed the lag.

A cross-variogram extends this approach into the multivariate analysis. Cross-variogram is defined as the variance of the difference between two variables of different types or attributes at two locations (Bailey and Gartell 1995):

$$\gamma(h) = \frac{1}{2N(h)} \sum_{i=1}^{N(h)} \left[z_1(x_i) - z_1(x_i + h)\right] \bullet \left[z_2(x_i) - z\ (x_i + h)\right] \qquad [2]$$

with definitions as in eq. 1.

Parameters obtained from the semivariograms were used to produce contour maps of the content of organic matter, clay and exchangeable calcium as well as soil pH in plough layer by means of the Kriging method for point interpolation (Warrick et al., 1986):

$$Z^*(x_0) = \sum_{i=1}^{n} \lambda_i \cdot Z(x_i) \qquad [3]$$

where: $Z^*(x_0)$- interpolated value of variable Z at location $x_0$, $(Z(x_i)$ - values measured at location $x_i$,, $\lambda_i$- weighed coefficients calculated on the basis of the semivariogram when:

$$\sum_{i=1}^{n} \lambda_i = 1 \qquad [4]$$

The weights, calculated in this way, make it possible to obtain non-biased interpolated values, i.e., the expected value: $E[Z^*(x_0)-Z(x_0)]=0$ and the estimated variance Var[ $[Z^*(x_0)-Z(x_0)]=$ *minimum*.

## Results

The soil of study area differs distinctly from other Euphrates soil, both in terms of geomorphological structure and the soil cover. This is related to the fact that the surface here is covered with flow till of a varying thickness and strongly outwashed. Wide flat elevations and nearly level slopes are covered with different subgrups of Gypsy soils. Usually they are eroded, to a different degree ranging from slightly to severely, as a result of accelerated anthropogenic denudation. This big diversity in the relief of the kame field and the soil cover causes, that despite the homogenizing cultivation carried out in this area for centuries, a big variability in organic matter of the soils investigated is observed. Table 1 presents the basic descriptive statistics of selected properties of the arable horizon of soils within the kame field.

| Variable | Min. | Max. | $\bar{x} \pm t_{\alpha;0,05}$ | (S$^{*}$) | Kurtosis | Skewness | CV(%) | (RMS$^{**}$) | Variance | (S. E$^{***}$) |
|---|---|---|---|---|---|---|---|---|---|---|
| Organic matter (%) | 0.00 | 1.92 | 0.84±0.09 | 0.47 | 2.31 | 0.0189 | 0.551 | 0.96 | 0.22 | 0.087 |

*) Standard deviation, **) Root Mean Square, ***) Standard Error

**Table 1: Summary statistics of the soil properties in humose horizon of kame field (n=30).**

The average content of organic matter in the plough of mineral soils found in the area under investigation equalled 1.76 % and clearly exceeds the content of organic matter in the soils in Euphrates region, Although the data concerning the content of organic matter shows a slight rightward skewness, in the case of 70 % of the samples analysed it fits within the range from 1.3 to 2 %. The highest variability is related mainly to the presence of agricultural erosion, which caused the destruction of the arable horizon and eluvial horizon over ca ¼ of the area studied; the current arable horizon was formed from the argillic horizon or directly from parent gypsum material. The negative effects of agricultural denudation are observed not only within the analysed of Euphrates soil. On the basis of the geostatistical analysis carried out, it was concluded that the analysed of organic matter contents are correlated over an area of 1500 m for organic matter. Table 2 presents the parameters for the spatial variability of soil properties models, included in figure 3. The spatial variability structure of organic matter content has been described by means of an exponential model. Although the properties analysed show average and large values of variability coefficients, the geostatical analysis demonstrates that they are characterised by a small random variability. However, the large share of systematic variability in the total spatial variability structure indicates that changes in the properties in the humose horizon are realised gradually, a situation which the homogenising cultivation has undoubtedly contributed to.

| Variable | Model | Nugget | Sill | Range (%) |
|---|---|---|---|---|
| Organic matter content (%) | Exponential | 0,031 | 0,364 | 1.9 |

**Table 1: Coefficient of the semivariogram and cross-semivariogram models**

The spatial variability of dependent soil properties was assessed using cross-variograms. The spatial correlation was described using an exponential model, the cross -variograms are similar in shape to semi-variograms, and a positive cross-variograms indicates that on average. According to experimental cross-variograms, the content of organic matter and exchangeable calcium in the arable horizon is correlated to a distance of 1500 m, Figure 3 presents the thematic maps of spatial variability in the content of: organic matter, which reflect the variability in the microrelief and systematic units of the land analysed. A larger content of organic matter is found in land depressions, where dark epipedons were formed

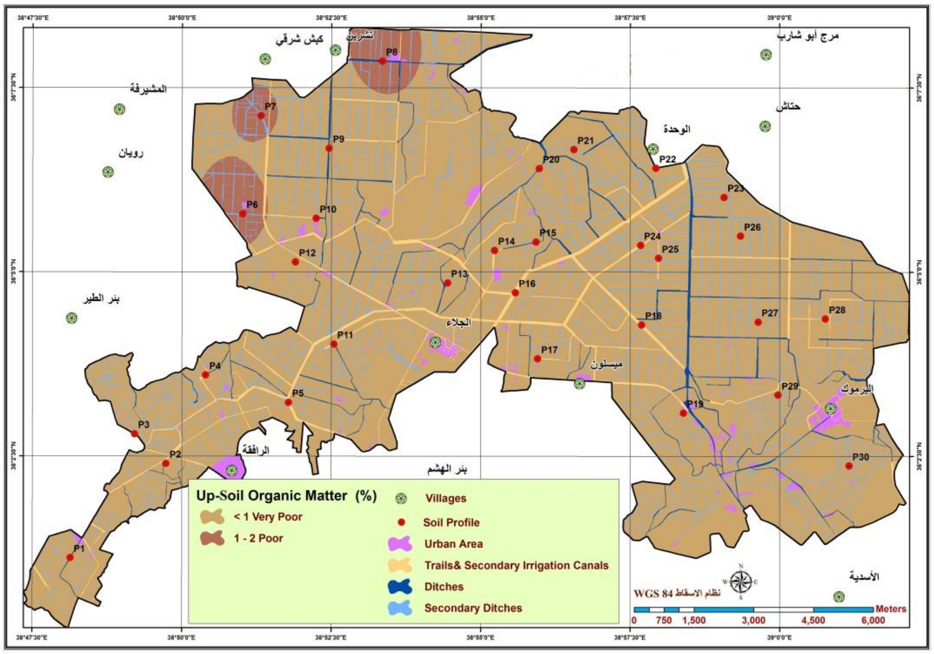

**Fig. 3: thematic map of organic matter content of study area.**

## Discussion

Based on empirical and theoretical models of semi-variograms and cross-variograms one could assume that the variety of organic matter content due to homogenising cultivation carried out using heavy machinery, a clear homogenisation of epipedon properties would occur in the plough layers. However, according to the thematic maps presented the spatial variability of organic matter content is strongly related to the variability of the microrelief and parent material, as well as features acquired during their genesis, which are secondarily impacted by anthropogenic factors. These soils demonstrate a rather high flexibility (Lal et al. 1998) and have not undergone complete transformation as a result of cultivation carried out for decades.

## Conclusions

Spatial distribution of organic matter content on study area demonstrate average and high values of the variability coefficient, the spatial analysis indicates that they exhibit a high systematic variability and low random variability, the values is correlated to a distance of 1500 m,

The microrelief and the variability of parent material determine the spatial distribution of organic matter content.

Spatial relationship between the content of organic matter determined on the basis of positive cross-variograms, is modified by agrotechnical cultivation measures.

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